In the Claims

This listing of claims will replace all prior versions, and listings, of claims in the application:

1\. – 14. (Canceled)

15\. (Previously Presented) A machine-implemented method comprising:

extracting portions from segment boundary regions of a plurality of speech segments, each segment boundary region based on a corresponding initial unit boundary;

creating feature vectors that represent the portions in a vector space;

for each of a plurality of potential unit boundaries within each segment boundary region, determining an average discontinuity based on distances between the feature vectors; and

for each segment, selecting the potential unit boundary associated with a minimum average discontinuity as a new unit boundary;

wherein the portions include centered pitch periods, the centered pitch periods derived from pitch periods of the segments, wherein the feature vectors incorporate phase information of the portions, wherein creating feature vectors comprises:

constructing a matrix W from the portions; and

decomposing the matrix W, and

wherein the matrix W is a $(2(K\text{-}1)+1)M \times N$ matrix represented by $W = U \Sigma V^T$

where K-1 is the number of centered pitch periods near the potential unit boundary extracted from each segment, N is the maximum number of samples among the centered pitch periods, M is the number of segments, U is the $(2(K\text{-}1)+1)M \times R$ left singular matrix with row vectors u_i $(1 \leq i \leq (2(K\text{-}1)+1)M)$, Σ is the $R \times R$ diagonal matrix of singular values $s_1 \geq s_2 \geq \ldots \geq s_R > 0$, V is the $N \times R$ right singular matrix with row vectors v_j $(1 \leq j \leq N)$, $R << (2(K\text{-}1)+1)M)$, and ^{T} denotes matrix transposition, wherein decomposing the matrix W comprises performing a singular value decomposition of W.

16. (Original) The machine-implemented method of claim 15, wherein the centered pitch periods are symmetrically zero padded to N samples.

17. (Original) The machine-implemented method of claim 15, wherein a feature vector $\bar{u}_i$ is calculated as

$$\bar{u}_i = u_i \Sigma$$

where u_i is a row vector associated with a centered pitch period i, and Σ is the singular diagonal matrix.

18. (Original) The machine-implemented method of claim 17, wherein the distance between two feature vectors is determined by a metric comprising a closeness measure, C, between two feature vectors, $\bar{u}_k$ and $\bar{u}_l$, wherein C is calculated as

$$C(\bar{u}_k, \bar{u}_l) = \cos(u_k\Sigma, u_l\Sigma) = \frac{u_k \Sigma^2 u_l^T}{\| u_k \Sigma \| \, \| u_l \Sigma \|}$$

for any $1 \leq k, l \leq (2(K\text{-}1)+1)M$.

19. (Original) The machine-implemented method of claim 18, wherein a discontinuity $d(S_1,S_2)$ between two candidate units, S_1 and S_2, is calculated as

$$d(S_1,S_2) = C(u_{\pi_{-1}}, u_{\delta_0}) + C(u_{\delta_0}, u_{\sigma_1}) - C(u_{\pi_{-1}}, u_{\pi_0}) - C(u_{\sigma_0}, u_{\sigma_1})$$

where $u_{\pi_{-1}}$ is a feature vector associated with a centered pitch period π_{-1}, u_{δ_0} is a feature vector associated with a centered pitch period δ_0, u_{σ_1} is a feature vector associated with a centered pitch period σ_1, u_{π_0} is a feature vector associated with a centered pitch period π_0, and u_{σ_0} is a feature vector associated with a centered pitch period σ_0.

20. (Original) The machine-implemented method of claim 19, wherein the same closeness measure, C, is used for optimizing unit boundaries and for unit selection.

21. - 34. (Canceled)

35. (Currently Amended) A <u>non-volatile</u> machine-readable storage medium having machine-executable instructions that when executed by a machine cause the machine to perform a machine-implemented method comprising:

extracting portions from segment boundary regions of a plurality of speech segments, each segment boundary region based on a corresponding initial unit boundary;

creating feature vectors that represent the portions in a vector space;

for each of a plurality of potential unit boundaries within each segment boundary region, determining an average discontinuity based on distances between the feature vectors; and

for each segment, selecting the potential unit boundary associated with a minimum average discontinuity as a new unit boundary;

wherein the portions include centered pitch periods, the centered pitch periods derived from pitch periods of the segments, wherein the feature vectors incorporate phase information of the portions, wherein creating feature vectors comprises:

constructing a matrix W from the portions; and

decomposing the matrix W, and

wherein the matrix W is a $(2(K\text{-}1)+1)M \times N$ matrix represented by $W = U \Sigma V^T$ where K-1 is the number of centered pitch periods near the potential unit boundary extracted from each segment, N is the maximum number of samples among the centered pitch periods, M is the number of segments, U is the $(2(K\text{-}1)+1)M \times R$ left singular matrix with row vectors u_i $(1 \leq i \leq (2(K\text{-}1)+1)M)$, Σ is the $R \times R$ diagonal matrix of singular values $s_1 \geq s_2 \geq \ldots \geq s_R > 0$, V is the $N \times R$ right singular matrix with row vectors v_j $(1 \leq j \leq N)$, $R << (2(K\text{-}1)+1)M)$, and ^{T} denotes matrix transposition, wherein decomposing the matrix W comprises performing a singular value decomposition of W.

36. (Currently Amended) The non-volatile machine-readable storage medium of claim 35, wherein the centered pitch

periods are symmetrically zero padded to N samples.

37. (Currently Amended) The <u>non-volatile</u> machine-readable storage medium of claim 35, wherein a feature vector $\bar{u}_i$ is

calculated as

$$\bar{u}_i = u_i \Sigma$$

where u_i is a row vector associated with a centered pitch period i, and Σ is the singular diagonal matrix.

38. (Currently Amended) The <u>non-volatile</u> machine-readable storage medium of claim 37, wherein the distance between

two feature vectors is determined by a metric comprising a closeness measure, C, between two feature vectors, $\bar{u}_k$ and $\bar{u}_l$, wherein C is calculated as

$$C(\bar{u}_k, \bar{u}_l) = \cos(u_k\Sigma, u_l\Sigma) = \frac{u_k \Sigma^2 u_l^T}{\|u_k \Sigma\| \ \|u_l \Sigma\|}$$

for any $1 \leq k, l \leq (2(K-1)+1)M$.

39. (Currently Amended) The <u>non-volatile</u> machine-readable storage medium of claim 38, wherein a discontinuity

$d(S_1, S_2)$ between two candidate units, S_1 and S_2, is calculated as

$$d(S_1, S_2) = C(u_{\pi_{-1}}, u_{\delta_0}) + C(u_{\delta_0}, u_{\sigma_1}) - C(u_{\pi_{-1}}, u_{\pi_0}) - C(u_{\sigma_0}, u_{\sigma_1})$$

where $u_{\pi_{-1}}$ is a feature vector associated with a centered pitch period π_{-1}, u_{δ_0} is a feature vector associated with a centered pitch period δ_0, u_{σ_1} is a feature

vector associated with a centered pitch period σ_1, u_{π_0} is a feature vector associated with a centered pitch period π_0, and u_{σ_0} is a feature vector associated with a centered pitch period σ_0.

40. (Currently Amended) The <u>non-volatile</u> machine-readable storage medium of claim 39, wherein the same closeness

measure, *C*, is used for optimizing unit boundaries and for unit selection.

41. – 54. (Canceled)

55. (Previously Presented) An apparatus comprising:

means for extracting portions from segment boundary regions of a plurality of speech segments, each segment boundary region based on a corresponding initial unit boundary;

means for creating feature vectors that represent the portions in a vector space;

for each of a plurality of potential unit boundaries within each segment boundary region, means for determining an average discontinuity based on distances between the feature vectors; and

for each segment, means for selecting the potential unit boundary associated with a minimum average discontinuity as a new unit boundary,

wherein the portions include centered pitch periods, the centered pitch periods derived from pitch periods of the segments, wherein the feature vectors incorporate phase information of the portions, wherein creating feature

vectors comprises:

means for constructing a matrix W from the portions; and

means for decomposing the matrix W, and

wherein the matrix W is a $(2(K\text{-}1)+1)M \times N$ matrix represented by $W = U \Sigma V^T$ where K-1 is the number of centered pitch periods near the potential unit boundary extracted from each segment, N is the maximum number of samples among the centered pitch periods, M is the number of segments, U is the $(2(K\text{-}1)+1)M \times R$ left singular matrix with row vectors u_i ($1 \leq i \leq (2(K\text{-}1)+1)M$), Σ is the $R \times R$ diagonal matrix of singular values $s_1 \geq s_2 \geq \ldots \geq s_R > 0$, V is the $N \times R$ right singular matrix with row vectors v_j ($1 \leq j \leq N$), $R << (2(K\text{-}1)+1)M$), and ^{T} denotes matrix transposition, wherein decomposing the matrix W comprises performing a singular value decomposition of W.

56. (Original) The apparatus of claim 55, wherein the centered pitch periods are symmetrically zero padded to N samples.

57. (Original) The apparatus of claim 55, wherein a feature vector $\bar{u}_i$ is calculated as

$$\bar{u}_i = u_i \Sigma$$

where u_i is a row vector associated with a centered pitch period i, and Σ is the singular diagonal matrix.

58. (Original) The apparatus of claim 57, wherein the distance between two feature vectors is determined by a metric comprising a closeness measure, C, between two feature vectors, $\bar{u}_k$ and $\bar{u}_l$, wherein C is calculated as

$$C(\bar{u}_k, \bar{u}_l) = \cos(u_k\Sigma, u_l\Sigma) = \frac{u_k \Sigma^2 u_l^T}{\|u_k \Sigma\| \|u_l \Sigma\|}$$

for any $1 \leq k, l \leq (2(K-1)+1)M$.

59. (Original) The apparatus of claim 58, wherein a discontinuity $d(S_1,S_2)$ between two candidate units, S_1 and S_2, is calculated as

$$d(S_1,S_2) = C(u\pi_{-1}, u\delta_0) + C(u\delta_0, u\sigma_1) - C(u\pi_{-1}, u\pi_0) - C(u\sigma_0, u\sigma_1)$$

where $u\pi_{-1}$ is a feature vector associated with a centered pitch period π_{-1}, $u\delta_0$ is a feature vector associated with a centered pitch period δ_0, $u\sigma_1$ is a feature vector associated with a centered pitch period σ_1, $u\pi_0$ is a feature vector associated with a centered pitch period π_0, and $u\sigma_0$ is a feature vector associated with a centered pitch period σ_0.

60. (Original) The apparatus of claim 59, wherein the same closeness measure, C, is used for optimizing unit boundaries and for unit selection.

61. – 74. (Canceled)

75. (Previously Presented) A system comprising:

a processing unit coupled to a memory through a bus; and

a memory unit storing a process executed by the processing unit to cause the processing unit to:

extract portions from segment boundary regions of a plurality of speech segments, each segment boundary region based on a corresponding initial unit boundary;

create feature vectors that represent the portions in a vector space;

for each of a plurality of potential unit boundaries within each segment boundary region, determine an average discontinuity based on distances between the feature vectors; and

for each segment, select the potential unit boundary associated with a minimum average discontinuity as a new unit boundary,

wherein the portions include centered pitch periods, the centered pitch periods derived from pitch periods of the segments, wherein the feature vectors incorporate phase information of the portions, wherein the process further causes the processing unit, when creating feature vectors, to:

construct a matrix W from the portions; and

decompose the matrix W, and

wherein the matrix W is a $(2(K\text{-}1)+1)M \times N$ matrix represented by $W = U \Sigma V^T$ where K-1 is the number of centered pitch periods near the potential unit boundary extracted from each segment, N is the maximum number of samples among the centered pitch periods, M is the number of segments, U is the $(2(K\text{-}1)+1)M \times R$ left singular matrix with row vectors u_i $(1 \leq i \leq (2(K\text{-}1)+1)M)$, Σ is the $R \times R$ diagonal matrix of singular values $s_1 \geq s_2 \geq \ldots \geq s_R > 0$, V is the $N \times R$ right singular matrix with row vectors v_j $(1 \leq j \leq N)$, $R << (2(K\text{-}1)+1)M)$, and ^{T} denotes matrix transposition, wherein decomposing the matrix W comprises performing a singular value decomposition of W.

76. (Original) The system of claim 75, wherein the centered pitch periods are symmetrically zero padded to N samples.

77. (Original) The system of claim 75, wherein a feature vector $\bar{u}_i$ is calculated as

$$\bar{u}_i = u_i \Sigma$$

where u_i is a row vector associated with a centered pitch period i, and Σ is the singular diagonal matrix.

78. (Original) The system of claim 77, wherein the distance between two feature vectors is determined by a metric comprising a closeness measure, C, between two feature vectors, $\bar{u}_k$ and $\bar{u}_l$, wherein C is calculated as

$$C(\bar{u}_k, \bar{u}_l) = \cos(u_k\Sigma, u_l\Sigma) = \frac{u_k \Sigma^2 u_l^T}{\| u_k \Sigma \| \; \| u_l \Sigma \|}$$

for any $1 \leq k, l \leq (2(K\text{-}1)+1)M$.

79. (Original) The system of claim 78, wherein a discontinuity $d(S_1, S_2)$ between two candidate units, S_1 and S_2, is calculated as

$$d(S_1,S_2) = C(u\pi_{-1}, u\delta_0) + C(u\delta_0, u\sigma_1) - C(u\pi_{-1}, u\pi_0) - C(u\sigma_0, u\sigma_1)$$

where $u\pi_{-1}$ is a feature vector associated with a centered pitch period π_{-1}, $u\delta_0$ is a feature vector associated with a centered pitch period δ_0, $u\sigma_1$ is a feature vector associated with a centered pitch period σ_1, $u\pi_0$ is a feature vector

associated with a centered pitch period π_0, and u_{σ_0} is a feature vector associated with a centered pitch period σ_0.

80. (Original) The system of claim 79, wherein the same closeness measure, *C*, is used for optimizing unit boundaries and for unit selection.

81. – 96. (Canceled)